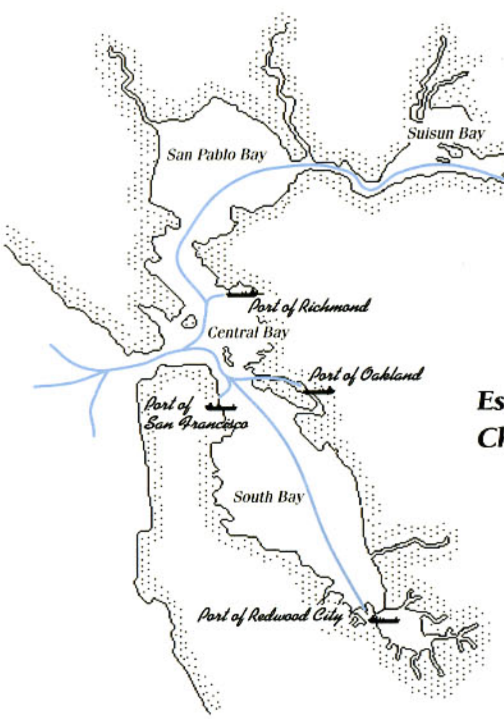
SAN FRANCISCO ESTUARY PROJECT

Dredging and Waterway Modification

Dredging removes sediment from the bottom of channels and harbors—an activity vital to both the navigability of the Bay and Delta, and to the regional economy. In the process, however, dredging can release sediments and toxics into the water, threatening plants, fish and the estuarine ecosystem. By building regional consensus on dredging, the San Francisco Estuary Project works to reconcile these environmental and economic issues as part of its ongoing planning effort to better manage the natural resources of the Estuary.

The Estuary

San Francisco Bay and Delta combine to form the West Coast's largest Estuary, conveying water from the Sacramento and San Joaquin Rivers to the Pacific Ocean. These waters deposit an estimated 8 million cubic yards (mcy) of sediment per year, while an additional 2.5 mcy comes from local streams. Approximately 4 mcy of sediment leave the Estuary through the Golden Gate Channel, while tides and winds recirculate and redeposit approximately 190 mcy of sediment within the Bay every year. The Estuary also hosts a rich diversity of aquatic life, including two-thirds of the state's annual salmon run, as well as nearly half of the waterfowl and shorebirds migrating along the Pacific Flyway.



Estuary Shipping Channels and Ports

Reasons for Dredging

As one of the critical maritime thoroughfares in the nation, channels and ports of the San Francisco Bay/Delta Estuary must be regularly dredged to allow large vessels to transport their load safely. Each year, over 4,000 commercial, ocean-going vessels, carrying over 50 million tons of cargo, navigate to public and private ports between Sacramento and Redwood City. In addition, over 1,000 commercial fishing vessels operate out of the Bay, and over 33,000 recreational boats dock at more than 200 marinas. These activities produce a maritime economy of over $7.5 billion per year. Today's largest ships require a draft of 50 feet, while two-thirds of the Bay measures less than 18 feet deep. Extensive dredging (ranging from 2 to 10 mcy per year) is necessary to maintain this maritime economy. In addition to keeping shipping channels, turning basins and docking slips navigable, dredging is often essential for such projects as building marinas, maintaining Delta levees, controlling floods and securing footings for bridges and piers. Due in part to the recent closure of military bases around the Estuary, the estimated amount of dredging needed in the Bay over the next 50 years has been reduced from 400 mcy to 300 mcy—or approximately 6 mcy per year on average. However, larger ships with deeper hulls are being built which will require deeper navigation channels.

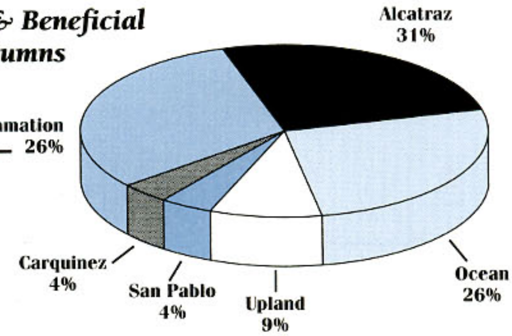
History of Bay Sediments

Over the years, several major activities have radically reduced the size and overall depth of the Estuary, added vast quantities of sediment to the Bay and Delta, and modified the routes of rivers and streams — increasing the need for dredging. Alteration of the Estuary's natural balance of water and sediment began a century ago, when massive quantities of sand, silt and crushed rock from gold mining washed downstream — stopping up creeks, obliterating whole bays (such as Vallejo Bay near Martinez), and reducing the Estuary's total area of open water. Between 1849 and 1914, about 1 billion cubic yards of sediment swept down from mining country into the northern estuary, laying down a layer of debris up to 3 feet thick.

The Gold Rush also spurred the development of homes, farms and businesses at the Estuary's edge. Over time, land reclamation of Bay and Delta margins, and the attendant building of hundreds of levees, reduced the total acreage of estuarine marshlands — an invaluable trap for sediment and buffer zone against erosion — by 85-95%. More recently, massive state and federal water projects have diverted millions of acre feet of freshwater from the Estuary to farms, towns and industry elsewhere in the Bay Area and California.

Dredging Operations

1994 Disposal & Beneficial Reuse Volumns



Glossary

acre foot: *An acre of water 1 foot deep.*

benthos: *Zone at the bottom of a body of water inhabited by mussels, clams, crustaceans and other aquatic life.*

bioaccumulation: *The uptake and accrual of contaminants which cannot be readily released due to the chemical nature of the contaminant, such as hydrophobicity, aqueous solubility, stability, and stereochemistry. Organic contaminants bioaccumulate more readily than other types.*

bioassay: *A laboratory test using live mollusks, fish or crustaceans to measure toxic response to sediment.*

bioavailability: *The extent to which a pollutant is available for uptake and accumulation by living organisms.*

biomagnification: *The process by which concentrations of pollutants increase as they pass up the food web such that each animal in the food web has higher tissue concentrations than did its food.*

biota: *Plants and animals of the region.*

bioturbation peat: *A complex mass of carbon used by microorganisms who then release carbon dioxide gas.*

draft: *The portion of a ship that is below the waterline.*

invertebrates: *Small organisms like worms and clams that lack a spinal column; many siphon water and suspended sediments for food.*

food web: *Network of interconnected food chains and feeding interactions.*

PAH and PCB: *Polycyclic aromatic hydrocarbons and polychlorinated biphenyls—two groups of toxic organic contaminants.*

plume: *An elongated cloud of suspended sediment.*

sediment: *Mud, sand, silt, clay, shell debris and other particles that settle on the bottom.*

slurry: *Sediments mixed with water.*

suspended sediments: *Undissolved particles floating in water.*

turbidity: *The clouding of a naturally clear liquid due to suspension of fine solids.*

water column: *Layer of water between surface and seafloor.*

Dredging Process

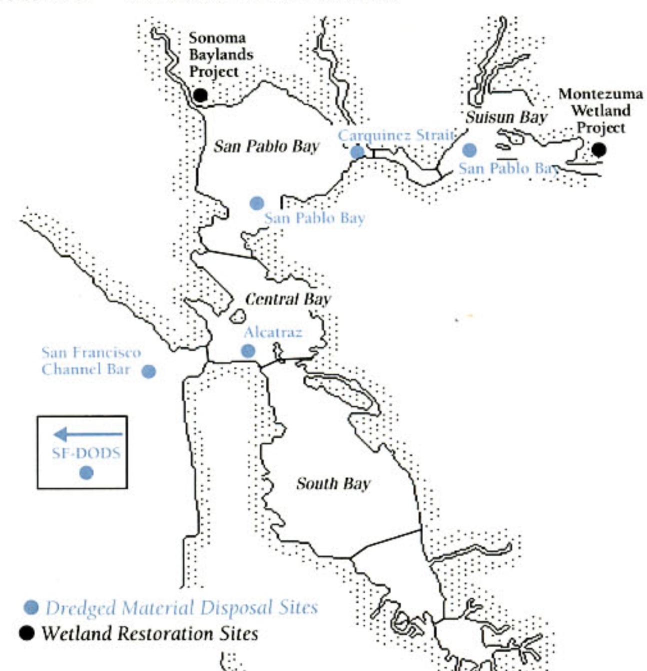
Dredging involves removing sediment from the Estuary floor, then transporting and placing that sediment at the appropriate disposal site. There are two ways to remove the sediment: with a **hydraulic dredge,** which pumps a sediment/water mixture (slurry) through a pipeline either directly to the disposal area or to a vessel for transport, or with a **mechanical dredge,** which scoops up large chunks of well-consolidated sediment onto a barge for transport to the disposal site. Hydraulic dredging is usually used for maintenance projects (where sediment has recently accumulated and is loosely compacted), while mechanical dredging is used for either maintenance or new-work projects. Hydraulic dredging is done with either a **Pipeline dredge,** which uses a rotating cutter to loosen the sediment as it gets pumped into a pipeline, or a **Hopper dredge,** which pumps the sediment into a self-contained hopper on the dredging vessel for transport. The mechanical **Clamshell dredge** uses a hinged bucket at the end of a cable to scoop up the mud.

Managing Dredging

The Corps of Engineers issues federal permits for dredging projects under Section 404 of the Clean Water Act, while the State issues water quality certifications according to Section 401. In the late 1980s these and other regulatory agencies were forced to reexamine their dredging policies when concern over the impacts of dredged sediment disposal escalated. The Alcatraz disposal site had gone from being 110 feet deep to 30 feet—a mounding problem which became a navigational hazard. Disposal site limitations, environmental concerns, and fragmented agency management resulted in dredging project delays. To overcome this "mudlock", the regulatory agencies (USEPA, USCOE, BCDC, RWQCB, and SWRCB), together with navigation interests, fishing groups, environmental organizations, and the public, initiated a cooperative effort to establish a comprehensive long-term management strategy (LTMS) for Bay Area dredged material. The primary goals of the LTMS are to develop an environmentally suitable and economically sensible approach to dredging over the next 50 years, to maximize the "beneficial reuse" of dredged material, and to develop a coordinated, stream-lined permit review process for dredging projects.

Disposal Sites

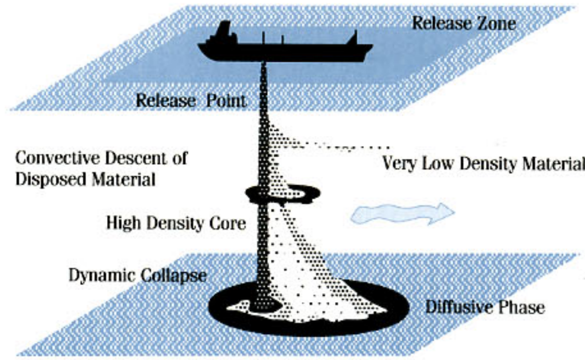
There are three types of disposal areas used for dredged material: in-Bay, ocean, or upland. Although sediment has been dumped throughout the Estuary in the past, in-Bay disposal sites are now restricted to primarily three areas: west of Alcatraz, the Carquinez Strait and Central San Pablo Bay. From 1992 through 1994, these sites received a total of 3.5, 3, and 1.4 million cubic yards, respectively, with Alcatraz getting roughly three-quarters of all in-Bay dredged disposal material. In-Bay disposal, however, was only part (39%) of the total volume dredged in 1994. In 1994, the EPA designated a new deep ocean disposal site off the continental shelf 57 miles west of the Golden Gate. Despite the higher cost of ocean disposal, this site is projected to be used for over 30% of dredged material in 1996. Upland disposal sites include both beneficial reuse (wetland restoration, levee repair, landfill reuse) and confined disposal (rehandling facility or permanent confinement). Some of the recent beneficial reuse projects include levee restoration at Jersey and Sherman Islands which used material from federal navigation channels. Wetland habitat restoration projects include Sonoma Baylands (using material from the Oakland Harbor) and the Montezuma Wetlands.



Active Aquatic Disposal Sites

Environmental Concerns

The environmental concerns related to the three disposal options vary, but in general, aquatic disposal methods have a greater potential to cause impacts than upland disposal due to increased exposure pathways.



Phases of Dredged Material Descent During Open Water Disposal.

Sediment Toxicity

Many of the Estuary's harbors and channels are a repository of the byproducts of decades of urban, industrial and agricultural development, although most of the sediments dredged from the Estuary do not pose a threat to human health or the environment. Common contaminants in sediment include heavy metals, Polychlorinated biphenyls, pesticides, and Polycyclic aromatic hydrocarbons. (See Glossary) Presently, the main "culprits" are nonpoint sources—runoff from urban and agricultural areas, stormwater discharges, and atmospheric deposition. These nonpoint sources are more difficult targets than the industrial and municipal discharges, which are now under much greater scrutiny than in the past (via tougher regulations). Point source discharges, however, still contribute trace levels of contaminants which can concentrate in the sediment. Contaminants in the sediment may become less intense but more widespread when natural mixing from tides and winds resuspend sediment, increasing contaminant bioavailability. Unlike most natural resuspension, dredged sediment is brought up from calmer waters of harbors and navigation channels where fine-grained sediment accumulates and where contaminants are most likely to occur. To prevent contaminant-laden sediment from being disposed of in-Bay, sediment is tested prior to dredging.

Food Web Contamination

Most heavy metals and organic contaminants remain bound to particles of sediment (particularly fine-grained clay particles), which are then taken up by filter-feeding organisms at the base of the food chain. By disturbing the sediment, dredging redistributes contaminants back into the water column, (particularly at a dispersive in-Bay disposal site), which potentially increases contaminant bioavailability. Other contaminant-related effects on biota are bioaccumulation and biomagnification. (See Glossary) The toxic effects (both chronic and acute) of various contaminants, and their background levels in the sediment, are currently being investigated.

Turbidity

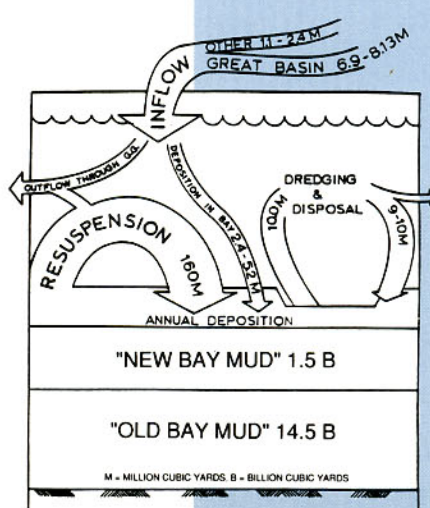
Whether hauling up or releasing sediments, dredging muddies the water. Disposal of dredged sediments produces greater amounts of turbidity than actual dredging. This turbidity is usually short-lived: most plumes of suspended sediment disappear within 20 minutes depending on site conditions, currents and the type of disposal equipment. When tiny plants (phytoplankton), animals or fish encounter a plume, the sediment can clog gills, mouth organs and respiratory surfaces and increase energy expenditure. Turbidity can also reduce phytoplankton photosynthesis by blocking light. At current and projected levels of Estuary dredging, scientists consider these effects stressful but nonlethal to the ecosystem.

Other Disposal Option Impacts

Although in-bay disposal is still the most predominant disposal method, the above impacts support the need to find other options for disposing of dredged material. Contaminants are potentially less of a problem when sediment is disposed of upland than within the Bay. For example, contaminants that are in a bioavailable form may not represent an adverse effect if organisms cannot be exposed to them, such as in a contained landfill. However, for other upland/reuse options, such as wetland creation, there are various pathways that pollutants can move; e.g., surface runoff, groundwater, plant and animal uptake via soil bioturbation. Another concern is the potential for salinity impacts from saline-laden sediments placed upstream. Although a different set of potential environmental impacts is associated with upland disposal, with proper design and monitoring these impacts can be minimized and the opportunity for creating environmental benefit extended. Environmental impacts associated with ocean disposal include accidental discharge within the protected waters of the Farollone Islands.

Fate of Disposed Sediments

Once dumped in the Bay, dredged sediments may settle on the bottom, disperse with tides or currents, or move out to sea. Clearly, the fate of dredged material after disposal is a function of the size, shape, moisture content and chemical structure of the material, as well as the characteristics of the disposal site and the hydrography of the estuary (tides, freshwater inflow and wind-driven currents). Beyond these basic details, however, the fate of disposed sediments remains unknown.



U.S. Army Corps of Engineers Projections of Sediment Movement in Estuary

Current Issues

The Delta

Resources

SFEP Information Sheets
The Estuary, The Delta, Wetlands, Pollution, Water Usage, Aquatic Organisms & Wildlife, Land Use, Decisionmakers & Managers, Research & Monitoring, Agricultural Drainage

SFEP Status and Trends Reports
Dredging & Waterway Modification; Aquatic Resources; Pollutants; and others. SFEP Comprehensive Conservation and Management Plan, 1993

LTMS
Phase I Evaluation of Existing Management Options; Study Plan for the S.F. Bay Region; Ocean Studies Plan

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LTMS–Policy EIS/Programmatic EIR

The purpose of the EIS/EIR was to seek public comment on the LTMS, and select a long-term management alternative that would achieve LTMS goals. The alternatives proposed are: 1) an emphasis on aquatic disposal (minimal upland/wetland reuse), 2) balancing upland/wetland reuse and in-Bay disposal (minimal ocean disposal), and 3) balancing upland/wetland reuse and ocean disposal (minimal in-Bay disposal). Although each alternative emphasizes one or more of the three disposal options (in-Bay, ocean and upland/wetland), all are meant, in the long-term, to decrease in-Bay disposal and increase beneficial reuse of dredged material.

Permit Streamlining

The LTMS agencies are currently fine-tuning a pilot one-stop interagency permit office for applicants seeking dredging permits. This interagency "dredge material management office" (DMMO) was designed to simplify the permitting process and improve how dredging operations are managed. The DMMO provides a framework for a coordinative decision-making process necessary for determining the proper disposal environment (in/Bay, upland/reuse, ocean).

Sediment Quality

In order to better determine whether a particular sediment is suitable for in-Bay disposal, the LTMS agencies improved their testing guidelines under USACE's Public Notice 93-2. Using a tiered approach to testing, these guidelines aid in generating physical, chemical, toxicity and bioaccumulation information, which can then be used to minimize unacceptable aquatic environmental impacts. For sediments destined for the Alcatraz site, protocol requires that test results be compared with Alcatraz Environs sediments, which have lower levels of contaminants than the Alcatraz site itself. In addition to gathering data from dredging projects, the state's Regional Monitoring Program (RMP) and Bay Protection and Toxic Cleanup Program (BPTCP) are investigating Bay-wide trends in sediment contamination. The RWQCB is also developing numerical sediment quality guidelines specific for San Francisco Bay sediments.

Cost issues

Although in-Bay disposal is still the cheapest method, environmental costs are beginning to be factored into the cost/benefit equation. Recent proposed federal legislation to amend the Water Resources Development Act (1986) would change the Federal cost-sharing structure, which now makes upland/beneficial reuse projects cost prohibitive. This legislation, the Environmental Dredge Disposal Act of 1996, currently under review, would allow greater flexibility in the funding mechanisms so as to lower the cost of upland disposal.

Waterway Modification

Delta waterways and marshlands have been filled, tidal flats diked, and river waters leveed, dammed and diverted. By the 1930's, about 100 Delta islands were drained after construction of 2,250 miles of levees throughout the Sacramento/San Joaquin Delta. Composed mostly of local dredged material, these levees are becoming increasingly unstable. Island subsidence (due to accelerated oxidation of peat soils from cultivation and dewatering) has been the principle contributor to this instability, along with the fact that most of the levee's foundations are composed of peat. As cultivation continues, land subsides, and water pressure on the levees increases, more material must be added to create broader and higher levees (some now stand over 30 feet high). Since the islands are below sea level, farming can continue only after seepage is pumped off to lower the water table.

The Delta's failing levees, coupled with a potential 3 1/4-foot sea level rise that some scientists project for the coming century, places the health and future of the Estuary's vast upper regions at risk. Increased erosion and flooding could seriously damage not only farmland and fisheries, but could also threaten the Estuary's natural resources and productive ecosystems. Use of dredged material to maintain weakening levees and islands in some cases, and to restore wetlands after breaching the levee at others, is being studied.

While dredging has topped the list of waterway modification concerns over the past few years, levee failure, subsidence, shoreline erosion, sea level rise and Delta flooding promise to become primary areas of research and action in the decade ahead.

Estuary Project Goals

The San Francisco Estuary Project's primary goal is to restore and maintain water quality and natural resources while promoting effective management of Bay and Delta waters. The Project's Comprehensive Conservation and Management Plan (CCMP) sets the following dredging-related goals for the 12-county Estuary region:

- *Adopt a sediment management strategy for dredging and waterway modification.*
- *Manage modification of waterways to avoid or offset the adverse impacts of dredging, flood control, channelization, and shoreline development and protection projects.*
- *Eliminate unnecessary dredging activities.*
- *Maximize the use of dredged material as a resource.*
- *Conduct dredging activities in an environmentally sound fashion.*

To achieve these goals, the CCMP's dredging and waterway modification section also proposes 15 specific actions ranging from developing sediment quality objectives to conducting field studies of dredging impacts on salt water intrusion in the Delta. For more information, contact (510)286-0460.

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